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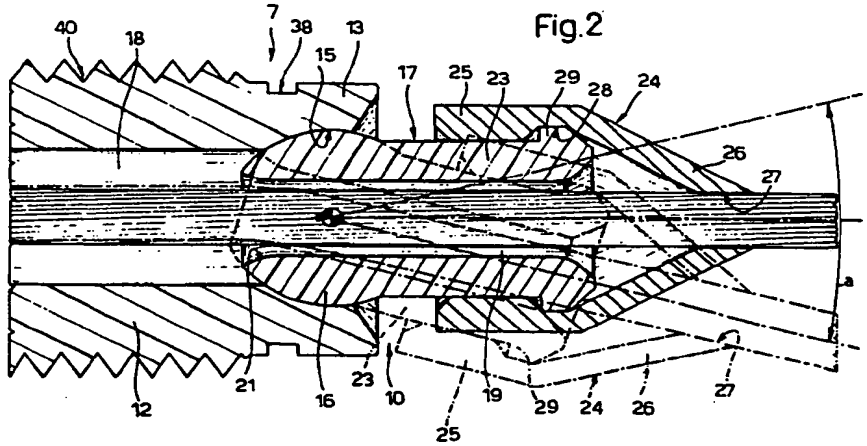
(54) Flexible cable provided with end connectors of improved type.

(57) The flexible cable (1) comprises an inner cable (2), the opposing ends (3, 4) of which are arranged to be connected for example to the accelerator pedal and to the injection pump of a vehicle internal combustion engine; a flexible sheath (5), in the interior of which the inner cable (2) is supported in an axially slidable manner; and a pair of opposing end connectors (6, 7), each of which is essentially fixed to the sheath (5) to enable it to be fixed to respective support elements (8, 9) when in use. At least one (7) of said connectors (6, 7) is provided at its outer end with a ball joint (10) housing the inner cable (2) and defining for this latter an exit trajectory from the connector (7), which trajectory is contained within a cone having a predetermined angle (a) at its vertex.

Fig.2



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FLEXIBLE CABLE PROVIDED WITH END CONNECTORS OF IMPROVED TYPE

This invention relates to a flexible cable provided with end connectors of improved type.

More particularly the invention relates to a flexible cable of the type comprising:

- an inner control cable, the opposing ends of which are arranged to be connected for example to the accelerator pedal and to the injection pump of a vehicle internal combustion engine;
- a flexible sheath, in the interior of which said inner control cable is supported in an axially slidable manner; and
- a pair of opposing end connectors, each of which is essentially fixed to the sheath to enable it to be fixed to respective support elements when in use.

The particularly severe working and environmental conditions under which flexible cables of the aforesaid type operate give rise to numerous problems which negatively affect the engine operation. Firstly, that end of the inner cable connected to the injection pump or rather to a lever thereof is subjected to considerable fatigue stress because of the positions which the lever can assume, and can rapidly deteriorate especially in that region between the connector and lever, due to the fact that this region cannot be enclosed within the sheath as the inner cable has to be able to move.

Further problems derive from the infiltration of dust, water and very small stones into the space between the sheath and inner cable, with consequent undesirable increase in the friction between them and reduced mobility of the inner cable within the sheath.

The object of the present invention is to provide a flexible cable able to overcome the aforesaid problems of known cables. Said object is attained according to the present invention by a flexible cable of the type comprising:

- an inner cable, the opposing ends of which are arranged to be connected to respective control and actuator means;
- a flexible sheath, in the interior of which said inner cable is supported in an axially slidable manner; and
- a pair of opposing end connectors, each of which is essentially fixed to the sheath to enable it to be fixed to respective support elements when in use;

characterised in that at least one of said connectors is provided at its outer end with a ball joint housing said inner cable and defining for this latter an exit trajectory from the connector which is contained within a cone having a predetermined angle at its vertex.

The present invention will be more apparent from the description of a preferred embodiment thereof given hereinafter by way of non-limiting example with reference to the accompanying drawings in which:

Figure 1 is a partly sectional simplified view of a cable constructed in accordance with the present invention; and

Figure 2 is a section through some details of Figure 1 to an enlarged scale.

In Figure 1 the reference numeral 1 indicates overall a flexible cable particularly but not exclusively usable for connecting the accelerator pedal to the control lever of the injection pump of an engine installed in a vehicle, preferably an industrial vehicle. The cable 1 is essentially of the type comprising:

- an inner cable 2, the opposing ends 3, 4 of which are arranged to be connected to said pedal and lever respectively;
- a flexible sheath 5 of conventional type, in the interior of which inner cable 2 is supported in an axially slidable manner;

and

- a pair of opposing end connectors 6, 7, each of which is essentially fixed to the sheath 5 to enable it, when in use, to be fixed to respective support elements indicated overall by 8 and 9.

According to the present invention the connector 7 is provided at its outer end with a ball joint (see also Figure 2) which houses the inner cable 2 and defines with this latter an exit trajectory from the connector 7, which trajectory is contained within a cone having a predetermined angle a at its vertex.

With particular reference to Figure 2, the connector 7 comprises a tubular sleeve 12 within which the inner cable 2 is mobile and which is provided with an end portion 13 comprising a concave seat 15 defined by a spherical surface and housing the spherical head 16 of a tube 17, said seat 15 and head 16 forming said ball joint 10.

The sleeve 12 has a through axial bore 18 of diameter greater than the diameter of the through bore 19 in the tube 17 of the joint 10, this latter bore 19 being of greater diameter than the inner cable 2 to allow correct sliding of the inner cable 2. In addition, at that end which communicates with the bore 18, the bore 19 of the spherical head 16 has a progressively increasing diameter so as to form a concave blending and guide surface which when in use facilitates the sliding of the inner cable 2 by preventing it from jamming in the spherical head 16 whenever the axis of the tube 17 is at its maximum angle to the axis of the sleeve 12 (see the position of the tube 17 indicated by dashed and dotted lines in Figure 2).

The tube 17 is provided with an end portion 23

extending from the spherical head 16 in the direction away from the sleeve 12 and beyond the end portion 13 of this latter.

A cap 24 of elastically deformable material such as rubber is mounted over the portion 23 of the tube 17. The cap 24 consists essentially of a tubular portion 25 with its inner diameter essentially equal to the outer diameter of the portion 23 of the tube 17, and a hollow conical portion 26 with a through end hole 27 the diameter of which is essentially equal to the diameter of the inner cable 2. In the connection region between its portions 25 and 26 the cap 24 comprises an annular groove 28 engaged by an annular projection 29 which extends radially outwards from the portion 23 of the tube 17.

With reference to Figure 1 the connector 7 is provided with a tubular bellows 30 the opposite ends 31, 32 of which are made rigid with the end portion 13 of the sleeve 12 and with the inner cable 2 respectively, so as to provide permanent protection against the external agents to that portion of the inner cable 2 extending beyond the cap 24, through a distance e which exceeds that distance through which, when in use, the inner cable moves relative to the connector 7 by the effect of the command which it receives from the accelerator pedal.

The end 31 of the bellows 30 is supported between two radial end projections 33, 34 provided on a rigid ring 35 which internally comprises an annular groove 36 partially engaged by an elastic ring 37 substantially housed in an annular groove deeper than the groove 36 and provided in the end portion 13 of the sleeve 12.

The end 32 of the bellows 30 has a diameter less than the diameter of the inner cable 2 so as to adhere perfectly to this latter and to move rigidly with it when in use.

The sleeve 12 is provided externally with a thread 40 and when in use is fixed on the support element 9 by two nuts 41, 42 and a washer 43, choosing the most suitable position.

At the opposite end to the end portion 13 the sleeve 12 comprises a further end portion 44, the inner diameter of which is substantially equal to the outer diameter of the sheath 5. Said portion 44 receives one end of the sheath 5 and is surrounded by a fixing ring 46 provided with a radial projection 47, the inner diameter of which is slightly greater than the outer diameter of the sheath 5. Between the abutting surfaces of the portion 44 of the sleeve 12 and the projection 47 of the ring 46 there is interposed an elastic ring 49 which when in use adheres perfectly both to the sheath 5 and to those surfaces of said ring 46 and portion 44 which face it. On installation, radial pressure is applied to the fixing ring 46 (for example by a tool with a hexagonal cavity) to mechanically secure it to the portion 44 of the sleeve 12.

The connector 6 is substantially of conventional type, being provided with a tubular body 50 fixed to the support element 8 and housing a slider 51 which is retained by a cup 52 and is mobile against the elastic action of a cylindrical spring 53.

Compared with known connectors of the same type it can be seen that in that part of the slider 51 contained within the body 50 there is an annular groove 54 housing an elastic ring 55. In addition a fixing ring 56 and an elastic ring 59, which are substantially identical with the fixing ring 46 and elastic ring 49 described heretofore with reference to the connector 7, are mounted over that end portion of the slider 51 which extends outside the tubular body 50. The connector 6 is also provided with a protection cap 60, which is identical to the cap 24 described with reference to the connector 7 and is installed on that end 61 at which the connector 6 is fixed to the support element 8, on that side of this latter facing the end 3. From the operational viewpoint the flexible cable 1 behaves exactly as known cables of the same type, in that the position of the accelerator pedal, which is connected to the end 3 of the inner cable 2, is transmitted by the inner cable 2 to the injection pump lever, which is connected to the end 4.

However it is apparent from an examination of the characteristics of the flexible cable 1 that it attains the aforesaid objects. Firstly, the ball joint 10 enables the inner cable 2 to adapt, when in use, to the various positions assumed by the injection pump, consequently reducing the effort which has to be expended on the inner cable 2.

The cap 24 not only guides the inner cable 2 for a further distance beyond the ball joint 10 but also prevents to a considerable extent any undesirable material such as dust, water, very small stones etc. present within the chamber delimited by the bellows 30 from depositing in the region in which the inner cable 2 emerges from the tube 17 of the ball joint 10, so avoiding any seizure of the inner cable.

The method used for fixing the ends 31, 32 of the bellows 30 to the sleeve 12 and inner cable 2 respectively further makes any infiltration of undesirable material into the region defined by the bellows difficult.

In this respect, the end 31 is well shielded externally by the annular projections 33, 34 of the ring 35, whereas internally it cooperates with the elastic ring 37, which provides a good seal. In addition the presence of the ring 35 supporting the end 31 means that if for some reason the bellows 30 has to be removed, there is no danger of damage to the end 31 if makeshift means (such as a knife, screwdriver etc.) are used to separate it

from the respective end portion 13 of the sleeve 12.

Because of the fact that the end 32 of the bellows 30 adheres tightly to the inner cable 2 and therefore moves together with it, the said portion e of the inner cable is maintained permanently in good condition, thus allowing correct movement without any fear of seizure in the ball joint 10.

Finally, entry of undesirable material between the sheath 5 and inner cable 2 is also effectively hindered by the elastic rings 46 and 56, the elastic ring 55 interposed between the slider 51 and body 53, and finally the cap 60.

It is apparent that modifications can be made to the described flexible cable 1 but without leaving the present invention. For example the ball joint 10 could also be provided in the connector 6.

Claims

1. A flexible cable of the type comprising:
- an inner cable, the opposing ends of which are arranged to be connected to respective control and actuator means;
- a flexible sheath, in the interior of which said inner cable is supported in an axially slidable manner; and
- a pair of opposing end connectors, each of which is essentially fixed to the sheath to enable it to be fixed to respective support elements when in use;
characterised in that at least one (7) of said connectors (6, 7) is provided at its outer end with a ball joint (10) housing said inner cable (2) and defining for this latter an exit trajectory from the connector (7), which trajectory is contained within a cone having a predetermined angle (a) at its vertex.

2. A cable as claimed in claim 1, in which said connector (7) comprises a tubular sleeve (12) within which said inner cable (2) is mobile, characterised in that said ball joint (10) consists of a concave seat (15) defined by a spherical surface and provided in an end portion (13) of said sleeve (12), and the spherical head (16) of a tube (17) within which said inner cable (2) is guided.

3. A cable as claimed in claim 2, characterised in that said sleeve (12) has a through axial bore (18) of diameter substantially greater than the diameter of the bore (19) through said tube (17), the diameter of the bore (19) through said tube (17) being greater than the diameter of said inner cable (2).

4. A cable as claimed in claim 3, characterised in that at that end communicating with said bore (18) through said sleeve (12), said bore (19) through said tube (17) has a progressively increasing diameter so as to define a concave blending and guide surface (21) which when in use facilitates the sliding of said inner cable (2).

5. A cable as claimed in any one of claims 2 to 4, characterised in that said tube (17) is provided with an end portion (23) which extends from said spherical head (16) in the direction away from said sleeve (12) and beyond said end portion (13) of this latter.

6. A cable as claimed in claim 5, characterised by comprising a protection cap (24) mounted over said portion (23) of said tube (17) and constructed of elastically deformable material.

7. A cable as claimed in claim 6, characterised in that said cap (24) consists essentially of a tubular portion (25), the inner diameter of which is essentially equal to the outer diameter of said portion (23) of said tube (17), and a hollow conical portion (26) comprising a through end hole (27) the diameter of which is essentially equal to the diameter of said inner cable (2).

8. A cable as claimed in claim 7, characterised in that in the connection region between its said portions (25, 26) said cap (24) comprises an annular groove (28) engaged by an annular projection (29) which extends radially outwards from said portion (23) of said tube (17).

9. A cable as claimed in any one of claims 2 to 8, characterised in that said connector (7) is provided with a tubular bellows (30) the opposite ends (31, 32) of which are made rigid with the end portion (13) of said sleeve (12) and with said inner cable (2) respectively, so as to provide permanent protection against the external agents to that portion of said inner cable (2) extending through a distance e which exceeds that distance through which, when in use, the inner cable (2) moves relative to the connector (7).

10. A cable as claimed in claim 9, characterised in that that end (31) of said bellows (30) rigid with said sleeve (12) is supported between two radial end projections (33, 34) provided on a rigid ring (35) which internally comprises an annular groove (36) partially engaged by an elastic ring (37) which is substantially housed in an annular groove (38) provided peripherally within said end portion (13) of said sleeve (12).

11. A cable as claimed in claim 10, characterised in that said annular groove (38) provided in said end portion (13) of said sleeve (12) is deeper than said annular groove (36) provided in the interior of said rigid ring (35).

12. A cable as claimed in claim 9 or 10, characterised in that that end (32) of said bellows (30) rigid with said inner cable (2) has a diameter less than the diameter of said inner cable (2) so that it adheres perfectly to this latter to move rigidly therewith when in use.

13. A cable as claimed in any one of the preceding claims in which one (6) of said connec-

tors (6, 7) is of the type provided with a tubular body (50) and housing a slider (51) which is retained partially within said tubular body (50) and is mobile against the elastic action of a cylindrical spring (53), characterised in that an elastic seal ring (55) is interposed between that part of said slider (51) contained within said body (50) and said body (50) itself.

14. A cable as claimed in any one of the preceding claims, characterised in that each portion of said connectors (6, 7) which is connected to said sheath (5) is surrounded by a fixing ring (46) provided with a radial projection (47), the inner diameter of which is slightly greater than the outer diameter of said sheath (5); between the abutting surfaces of each connector (6, 7) and the projection (47) on said fixing ring (46) there being interposed an elastic ring (49) which when in use adheres perfectly both to said sheath (5) and to those surfaces of said ring (46) and of said connectors (6, 7) which face it.

15. A cable as claimed in claim 14, characterised in that said fixing ring (46) is subjected to radial pressing to mechanically secure it to said portion (44) of said sleeve (12).

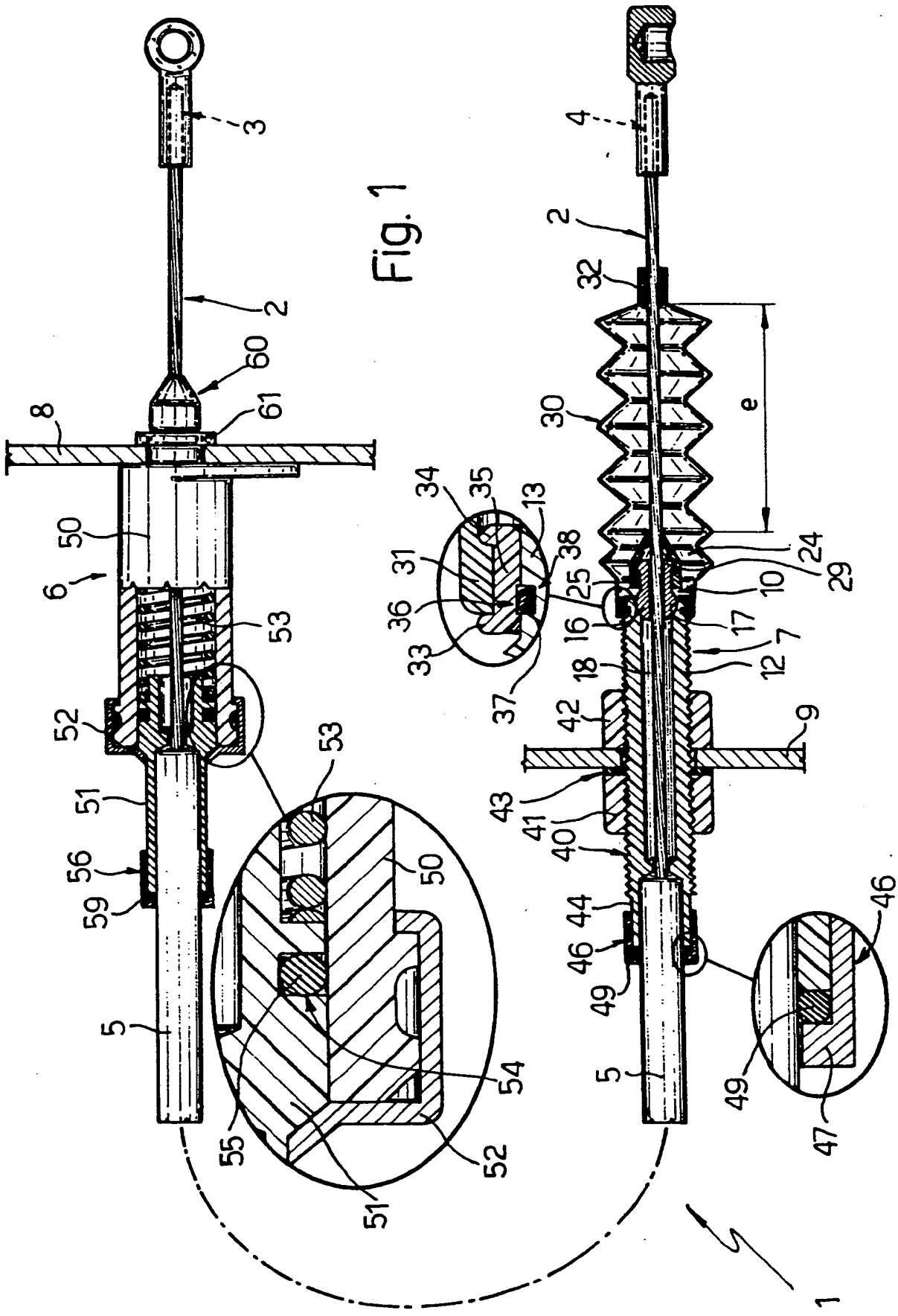
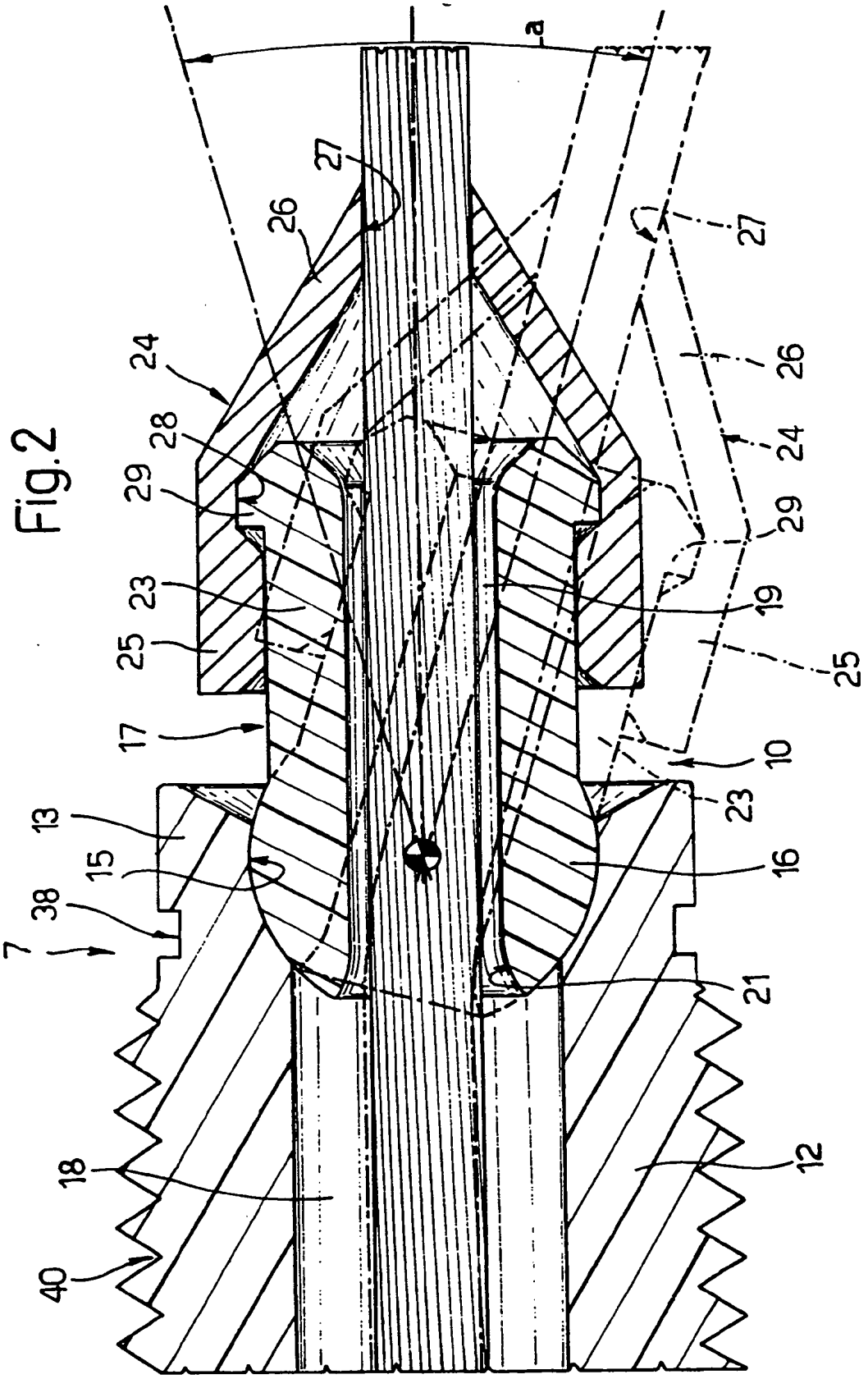


Fig. 1

Fig.2



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EUROPEAN SEARCH REPORT

Application Number

EP 90 10 8243

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-4238974 (CABLECRAFT) * column 3, lines 65 - 68 * * column 4, lines 1 - 36; figures 6-8 *	1	F16C1/26
A	US-A-4333361 (TELEFLEX) * column 2, lines 60 - 67; figures 1-3 *	1	
A	US-A-4790205 (FORD) * column 2, lines 47 - 60; figures 1-3 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F16C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 JUNE 1990	CERIBELLA G.

CATEGORY OF CITED DOCUMENTS

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